(12) UK Patent Application (19) GB (11) 2 035 208 A

(21) Application No 7936003
(22) Date of filing 17 Oct 1979
(30) Priority data
(31) 2845401
(32) 18 Oct 1978
(33) Fed Rep of Germany (DE)
(43) Application published
18 Jun 1980
(51) INT CL[3]
B42D 15/02
(52) Domestic classification
B6A GB
(56) Documents cited
GB 2017369A
GB 1376505
GB 1365378
GB 1353244
GB 1146289
GB 992320
(58) Field of search
B6A
C7F
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(54) A printed security with hallmarks

(57) The invention relates to a printed security with a hallmark in the form of a coating applied in a vacuum to the surface of the security. This coating is so thin that it is almost invisible, even if made of metal, while at the same time permitting accurate automatic examination. The absorption characteristics of the security are preferably measured in a certain range of wavelengths of the spectrum.

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FIG. 1

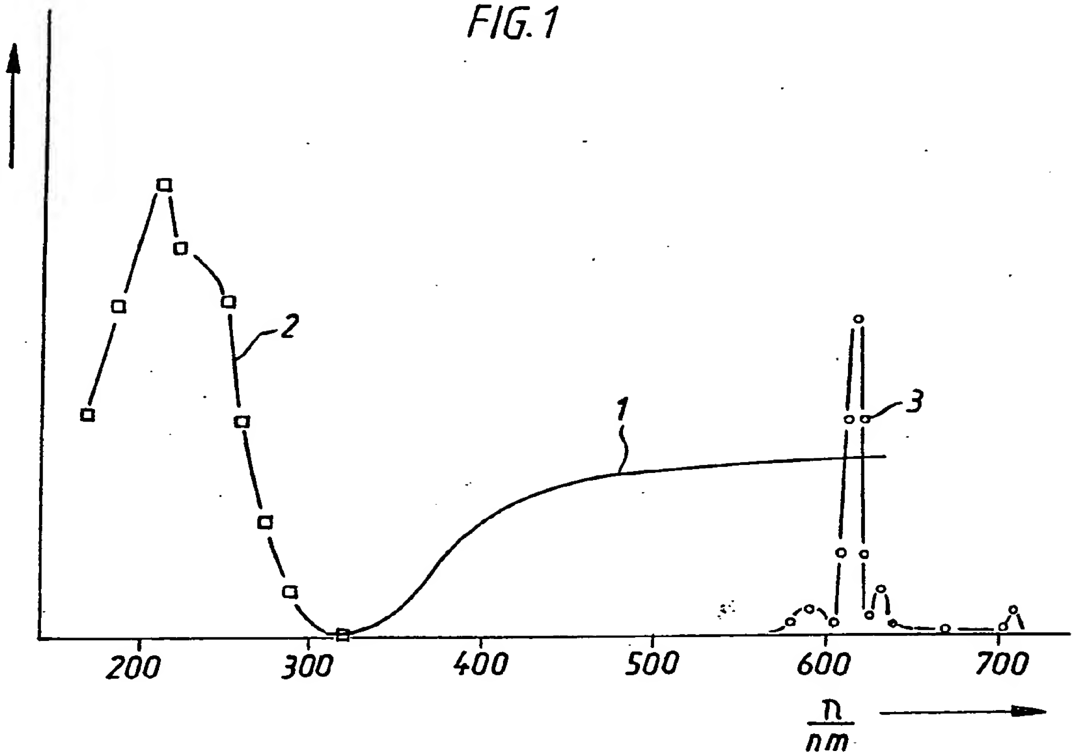


FIG. 2

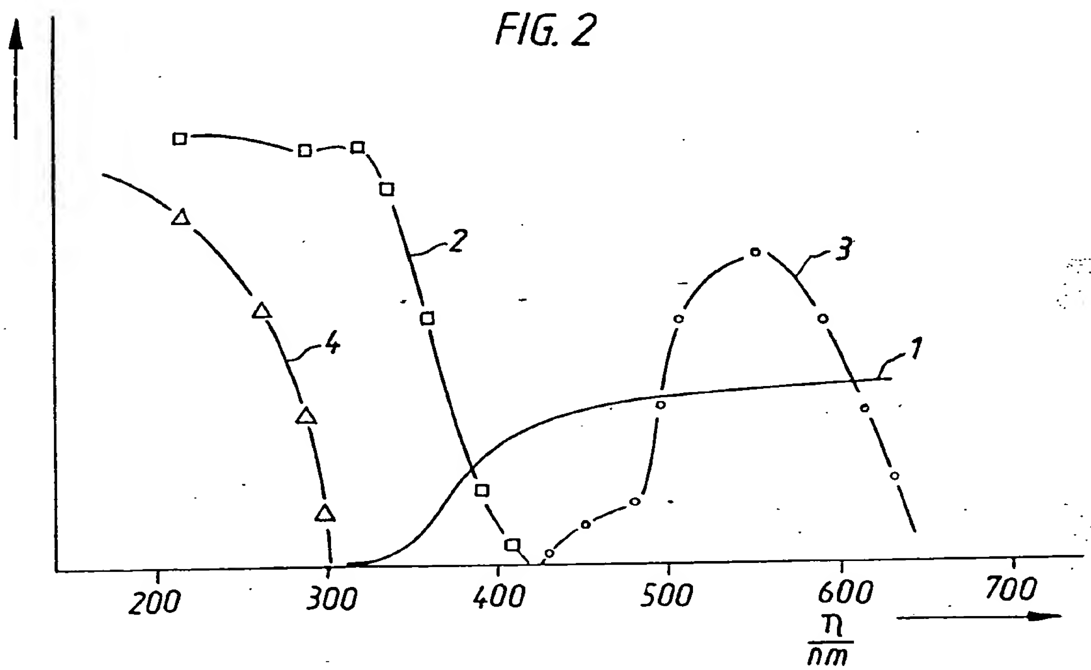
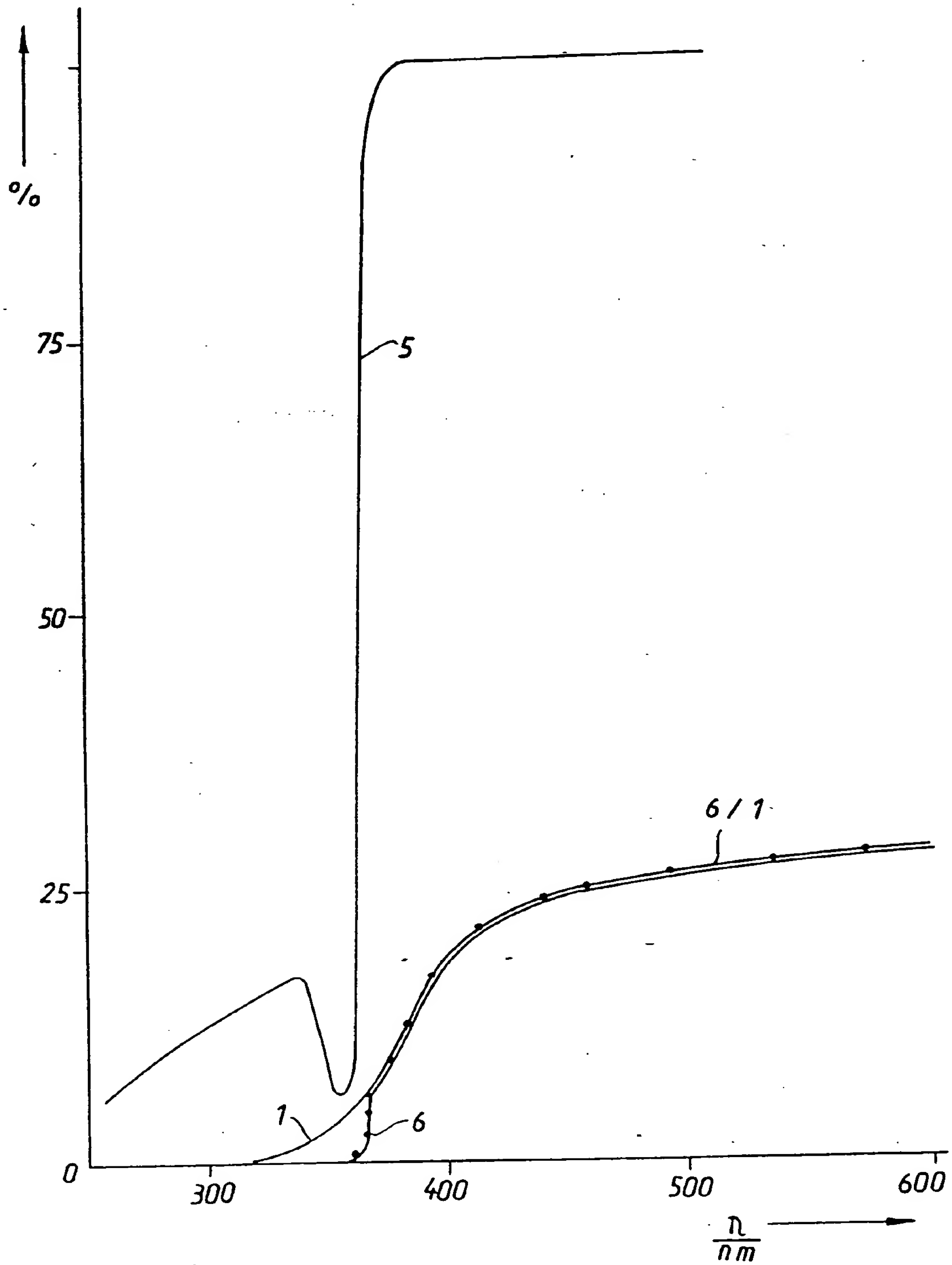


FIG. 3



SPECIFICATION

A printed security with hallmarks

This invention relates to a printed security with hallmarks as well as to a method for inspecting such a security.

In order to obviate forgeries and fakes it has long been known to design or provide securities requiring protection in such a way that imitation or alteration by unauthorised persons is rendered impossible or so hampered that the expenditure required to do so substantially exceeds the profit to be gained.

In order to attain this goal, in particular those safety techniques have proved themselves in the past which necessitate on the one hand a very high expenditure for the apparatus and labour invested which forgers cannot raise, thus making the production of small numbers uneconomical; and safety techniques on the other hand whose features cannot be inspected definitively as to their authenticity by anyone without any additional equipment and without a great amount of expertise. If a plurality of hallmarks is employed simultaneously, such hall marks originating preferably from different sectors of technology and being added to the security during various stages of the production process, the safeguarding effect can be enhanced substantially. Since during circulation securities are subject to considerable strain and wear, one requirement must be that the hallmarks to be used can be detected well in unchanged form even in case of highly worn securities. Providing the securities with true watermarks as well as with safety threads which can only be supplied by means of expensive apparatus during the manufacturing process has proved successful in particular in the case of bank notes. Likewise, valuable as hallmarks are extremely fine steel gravure printing patterns, which are very labour-intensive.

A strong trend to automation has also made itself felt for some time now in general payment transactions. It is thus necessary to provide in addition to the cited, visually inspectable hallmarks others which can be recognised as being authentic by automatic inspection instruments with the same or even greater safety.

Securities with automatically inspectable hallmarks have been known from the patent literature for some time. German Offenlegungsschrift 2,328,880 describes a safety paper in which fibers which can be magnetized in a preferable direction are admixed with the pulp. These fibers have a core of plastics, carbon or the like, the surface of which is coated with a commercial magnetizable material. The coating is preferably electrodeposited, but can also be effected by vacuum evaporation or by other deposition methods.

To be able to detect these dark fibers during inspection, however, it is necessary to admix them in such a concentration that they impart to the paper a dark gray appearance similar to packing paper. Moreover, the automatic checking instrument in accordance with German Offenlegungsschrift 2,417,564 which is proposed to inspect the resultant magnetic field is disproportionately expensive.

A safety thread for securities with a novel, automatically inspectable hallmark is proposed in German Auslegeschrift 2,212,350. The thread is designed as a hollow filament of transparent plastics, and the internal cavity being filled with liquid crystals and fused together. The filling is selected such that a colour change can be registered at a specific temperature which can be chosen between the limits of −50°C and +250°C.

A safety thread according to this invention, however, can hardly be expected to withstand the mechanical strain to which a bank note, for instance, is subject during circulation. Imprints by means of the steel gravure printing procedure would rupture the hollow filaments and allow the hallmark substance to escape. If the bank notes were folded, the same consequences would have to be expected.

In addition to the above-cited features, there is a plurality of other features with magnetic, electrical or optical properties. Fluorescent substances are mentioned in this context as being representative of the others. The fluorescent substances are either admixed to the pulp during paper production or are incorporated into the still moist, semi-finished paper or printed onto the finished paper. Reference is made only by way of example to German Patent Specification 2,320,731 from which it is already known to apply to one or more sites on a security fluorescent substances of a specific concentration which have a characteristic fluorescent spectrum, preferably emission line duplets.

The authenticity of the security can be determined with high reliability by quantitatively measuring the fluorescent spectrum. Since the hallmark substances are printed onto the finished paper afterwards, the protection which can be achieved is less than that achieved by the application process and the hallmark substances themselves must be safeguarded in general by rigorously restricting their availability.

German Offenlegungsschrift 2,623,365 recites a hallmark consisting, for instance, of a metal film vacuum-evaporated onto a substrate. Another semiconductor or photoconductive layer is then vacuum-evaporated onto the metal film. The surface is formed by a thin dielectric foil. An electrical conductivity pattern is introduced into the middle layer which can be rendered visible in the form of a charge image on the surface of the dielectric foil, can be read, and, after reading, can be cancelled or erased again. The conductivity pattern in the middle layer, however, is permanent. The known hallmark serves to protect specific bits of information or serves to identify the authenticity of recording carriers such as identification cards, cheque cards and the like which all have a multi-layer structure. This hallmark, however, is unsuitable for safeguarding a paper carrier such as a bank note or share certificate, for example.

It is known from German Patent Specification 2,530,905 to protect the printed image of a security by a homogeneous layer which has a specific reflection or fluorescent properties which differ from those of the security or the printing ink. Damage to this protective layer by erasing or other manipulation can be visually detected by means of suitable

illumination. To obtain good adhesion to the surface of the security to be protected, the protective layer must necessarily have a binder which falsifies the measurement of certain physical properties such as the reflection and transmission of the printed image in certain wavelength ranges.

Since the forger does not as a rule posses a paper machine, introducing hallmark substances into the paper during its production provides considerable protection from forgery. For inspection purposes, it is very desirable to provide a possibility for differentiating between those hallmark substances which are merely printed onto and those introduced directly into the paper owing to the different degrees of difficulty in imitating them. It is generally impossible in practice to make such a differentiation in the case of optically effective hallmarks, since the binders used for printing exhibit an absorption behavior similar to that of the paper. Although the hallmark substances can also be printed invisibly, i.e. without adding coloured printing pigments, the person skilled in the art has knowledge of methods for subsequently rendering the printing varnish visible again.

Securities which have been equipped with hallmarks by embedding them into the paper mass or by printing them on the paper offer only inadequate protection from special methods of forgery known to the person skilled in the art. If a bank note is torn in half, for example, hallmarks embedded in the paper mass will be found in both halves of the bank note. If the printing ink of the bank notes is dissolved by solvents and is transferred in part to foreign paper, hallmarks which were in the printing ink will also be transferred at the same time in part.

In light of these drawbacks of known hallmarks, it is desirable for the production of securities to have new hallmarks with other properties available. A commensurate expenditure for the authenticity protection can then be made depending on the intended purpose and value of the respective document.

In accordance with the present invention there is provided a security having one or more hallmarks in the form of a coating on the external surface of the paper substrate, the coating being free of binders and being applied in a vacuum. Neither binders nor pigments are used to deposit or apply the hallmarks which are known per se and which constitute the coating. The result is nonetheless a surface coating on the paper which has good adhesive properties and which, if desired, can be invisible. This thus eliminates any action or effect of the commercially employed binders which adulterates or invalidates the physical properties such as fluorescence or ultraviolet light absorption.

The hallmarks of the security of the invention thus have deposition-specific properties which cannot be obtained by means of other deposition techniques or forgery techniques. They are reliably inspectable in automatic machinery and are thus well protected from forgery, imitation or counterfeiting.

A preferred method for depositing the surface coating is cathode sputtering. For this purpose, the printed security, which has not yet been provided with the hallmarks, is put into a vacuum chamber where the air is evacuated and the hallmark substance is then applied. Suitable facilities for sputtering coatings on paper are known and described in German Offenlegungsschrift 2,400,410. Facilities of this kind are available on the market in single-piece production.

The hallmark substance is advantageously applied to the security only in strips. This saves material on the one hand and on the other hand a standard of comparison is obtained for the inspecting procedure.

The characteristic, thin and well-adhering coating of the paper fibers achieved by means of cathode sputtering is very resistant to wear, consists exclusively of the hallmark substance and includes no additives. Such prepared papers thus exhibit a number of advantages which cannot be obtained with other, hitherto employed deposition methods. This will be explained in more detail in the following with reference to a few examples, although the invention is not intended to be restricted to the cited examples. It is of course possible for the person skilled in the art to enumerate other applications in which the afore-mentioned advantages of sputtered hallmark layers can be utilized.

A simple and effective authenticity inspection is possible using a hallmark which can be excited to fluoresce in a wavelength range in which the transmission of the security paper and the analogous behaviour of the binders and pigments is normally reduced to zero. When excited in this wavelength range, the fluorescent emission of hitherto known types of coating has not been achieved in an intensity adequate for practical inspection without a substantially greater use of material. The reason is the optical behavior of the paper employed whose transmission is illustrated by curve 1 in Figure 1. The transmission of the paper drops to almost zero in the wavelength range from 300-400 nm. Hence, the fluorescent substances introduced into the pulp cannot be adequately excited by light with a wavelength less than 350 nm. Owing to the similar absorption behavior of binders and pigments, the printed layers of the fluorescent substances behave similarly.

Yttrium oxide (Y_2O_3) dosed with europium oxide (Eu_2O_3) is used preferably as the hallmark substance for this application. This material has special optical properties; it fluoresces in an extremely narrow band at approximately 600 nm when the fundamental lattice is excited with light in the wavelength range less than 300 nm (literature: N.Riehl, "Introduction to Luminescence", Karl Thiemig Verlag, Munich, 1970, page 127). The excitation spectrum is illustrated as curve 2 in Figure 1, the emission spectrum as curve 3. These curves represent literature values. As test have shown, the corresponding values of the sputtered layers can deviate with respect to their magnitude, but qualitatively still exhibit the same shape.

Should the forger succeed at all in identifying the fluorescent behaviour of the hallmark substance, he will then attempt to produce the excitation spectrum in the wavelength range in question, i.e. with light less than 300 nm, with a fluorescent emission at 600

nm. He could succeed, depending on the circumstances, by making a considerable expenditure of material, for example. Since this coating must be deposited using conventional methods, i.e. binders and pigments must be applied together with the hallmark substance, the absorption behaviour of the paper or of the binder and pigments will determine the intensity of the fluorescent emission. The authenticity of the security can then be moved reliably when measurements are made at two different lications, both of which have a shorter wavelength than 300 nm. The fluorescent emission, however, of the security upon which a binder-free coating has been sputtered is almost entirely independent of the wavelength used for excitation during both measurements. If the security has been forged, the intensity of the fluorescent emission will be clearly lower when excited with the shorted wavelength due to the higher absorption of the binders and pigments.

Yet another advantage is that the sputtered layer cannot be dissolved in the organic agents with which a colour coating can be applied to a forgery. Hence, if such an attempted forgery is undertaken, the hallmark substance will subsequently not exist on the fake, thereby making such a fake readily identifiable even in the case of automatic inspection.

Even if the paper is torn into two halves, only one half would have the hallmarks in the case of the inventive coating. Upon inspection, one of the two halves would become conspicuous in any case as being the fake.

Another, equally effective inspection method results when a hallmark substance is used whose fluorescent emission can be excited by irradiation with wavelengths less than 400 nm. The fluorescent emission can exhibit a relatively broad band. Curve 1 in Figure 2 again depicts the transmission of the security itself, curve 2 illustrates the excitation spectrum and curve 3 the emission spectrum (literature values).

One hallmark substance which exhibits such behaviour is zinc sulfide dosed with copper, for example.

If the forger examines a true security for fluorescence under ultraviolet lamp, he will discover a broad-band fluorescent emission and will print the genuine or a similar fluorescent substance on his forgery. Under his examination conditions, i.e. with an excitation spectrum up to approximately 400 nm, the forged security will fluoresce like a genuine security. In the case of the authenticity inspection performed in authorised examination instruments, however, the exciting wavelength is restricted to the range less than 300 nm. In this case, only the true security will exhibit fluorescent emission, while the fluorescent substances printed on the security together with binders and pigments will not be adequately excited at this short inspection wavelength due to the high absorption of the binders and pigments. The shorter wavelength of the inspection spectrum compared to the excitation spectrum (curve 2 in Figure 2) is illustrated by curve 4 in Figure 2. The special effect of this inspection method is, among other things, to leave the forger in the dark about the actual inspection information.

In another example, the hallmark substance has photoconductive properties. A suitable hallmark substance is zinc sulfide dosed with copper as was used in the previous example. The hallmark is inspected by measuring the photoconduction in the area of a ZnS:Cu strip to the security. In so doing, a glass plate is pressed down on the security. The glass plate was previously provided on the contact side with two electrodes separated only by a small gap. Using this assembly, the electrical conductivity of the strip can be detected in the dark through the glass plate when the site of measurement is illuminated intensively, thereby determining the photoconduction under the specified examination conditions. The effect can be intensified by arranging the electrodes so that they mesh with one another like combs. The examination procedure described above can of course also be combined with examination of the fluorescent emission in accordance with the previous example.

Yet another effective examination procedure results when the hallmark substance has ultraviolet-absorbing properties. A suitable substance for this purpose is zinc oxide (ZnO), for instance. The security used may exclusively contain filler materials such as barium sulfate which are permeable to ultraviolet light in this case. The spectral transmission curve of uncoated bank note paper is shown qualitatively by curve 1 in Figure 3. Curve 5 represents the transmission of the chosen hallmark substance (literature values). If the applied hallmark layer is not supposed to be visible, the absorption edge must lie in the lower range of transmission of the uncoated bank note paper. The transmission of the coated bank paper is illustrated by the broken curve 6. Figure 3 reveals clearly that the transmission of the coated bank note paper adjacent to the absorption edge of the hallmark substance exhibits an irregularity. If the bank note is irradiated with light of a shorter wavelength, it will be practically opaque; if it is irradiated with light of a longer wavelength, it will supply approximately the transmission of the uncoated bank note paper. The printed colour of the paper does not change for all practical purposes because the visible frequency spectrum remains substantially the same.

A forgery can be identified by measuring the change in the bank edge which constitutes an excellent means for detecting and determining the authenticity of the security. The measurement can be performed in the known manner using a commercial reflection spectrometer.

In a preferred embodiment, the ultraviolet-absorbing layer is only sputtered onto the security in the shape of strips so that these locations can be compared to the untreated portions of the upper during examination. The characteristic change in the absorption pattern cannot be obtained by printing, since usual printing techniques do not result in continuous, saturated layers – microscopically speaking – but rather cover only a small portion of the surface to be printed. When irradiated with light which has a shorter wavelength than the critical wavelength of the absorption edge of the hallmark substance, the transmission would thus attain a detectable mag-

nitude in the case of a forgery, whereas it is practically zero in the case of a true security.

The hallmark substance can also be applied in the form of a marginal strip, for example. This is in particular interesting in the case of bank notes when these marginal strips are also to be taken into consideration to determine whether or not the bank note has been torn.

When inspecting the bank note for tears, one side of the bank note is irradiated adjacent to the absorption edge of the uncoated paper with shortwave radiation while the measurement is made on the other side. Due to the absorption behaviour of the spattered layer, the marginal strip will appear dark. Tears, even if they have been overlapped and mended by mechanical pressure, will exhibit a transmission which is higher by a multiple because the intensively absorbing cover layer has been destroyed at these locations.

This hallmark is also immune to forgery methods such as tearing and reprinting for the reasons cited hereinbefore.

Although the most interesting of the new properties, which are produced by sputtering even hallmark substances which are already known per se, are of an optical nature, the range of application of this process is in no way restricted to optically effective hallmarks. Advantages also result in case of non-optical hallmarks as well, as for example when the hallmark substance is electrically conductive.

Suitable paper is sputtered with stannic oxide (SnO_2) analogously to the examples described hereinbefore. The thin, invisible hallmark strips exhibit electrical conductivity which can be examined by means of the known procedures. A suitable device is already described in German Offenlegungsschrift 263,699, for example. An optical transmission measurement must also be performed at the measurement site at the same time, however, in order to differentiate the invisibly conducting areas from forgeries in which, for instance, conducting carbon black paints or conducting varnishes based on metal colloids have been applied. The coating exhibits a substantially improved homogeneity compared to conductive strips applied to the paper by other deposition procedures. The resultant, clearly improved reproduceability of the conductivity values makes it possible to select narrower measurement tolerances than was hitherto possible.

These examples show that the application of hallmark substances known per se onto security or safety paper by cathode sputtering or like vacuum deposition process gives rise to new hallmark properties. These permit a clear and distinct determination of whether a security was provided with hallmark substances by vacuum deposition or whether these substances were applied by different methods. Because vacuum deposition of hallmark substances onto securities otherwise necessitate an extraordinarily high expenditure, securities treated in this manner provide a valuable protection against forgery which also lends itself to automatic inspection and examination.

The safety thread and watermark hallmarks, which are important in particular for visual inspection, ultimately derive their unforgeability from the fact that they can be provided only during paper manufacture, that an appropriate paper factory cannot be put into operation inconspicuously and that this would turn out to be more expensive to the forger anyway and would not be compensated for by any possible profits. The circumstances associated with vacuum deposition hallmarks are comparable. Suitable facilities can be built only in single-piece production by a few conspicuous manufacturing companies. The plants – of which only a very few exist – are expensive, require much know-how and cannot be put into operation and maintained without arousing some attention. Such plants can only operate economically on the basis of quantities which cannot be achieved with forgeries.

CLAIMS

1. A printed security having a hallmark in the form of a coating on the external surface of a paper substrate, the coating being free of binding agents and having been applied in a vacuum.

2. A security according to claim 1, wherein the coating consists of metals and/or metal compounds.

3. A security according to claim 2, wherein the coating is applied by cathode sputtering.

4. A process according to any one of claims 1 to 3, wherein the coating is applied in the form of strips.

5. A security according to claims 1 to 4, wherein the coating has fluorescent properties.

6. A security according to claim 5, wherein the fluorescent emission of the coating can be excited by light with a wavelength less than 400 nm.

7. A security according to claim 5, wherein the fluorescent emission of the coating can be excited by light with a wavelength less than 300 nm.

8. A security according to claim 6 or 7, wherein the coating consists of yttrium oxide dosed with europium oxide.

9. A security according to any one of claims 1 to 7, wherein the coating has photoconductive properties.

10. A security according to claim 9, wherein the coating consists of zinc sulfide dosed with copper.

11. A security according to any one of claims 1 to 4, wherein the coating has ultraviolet-absorbing properties.

12. A security according to claim 11, wherein the coating and the material of the security are matched in such a way that the absorption edge of the coating is still in the final short wave range of the transmission curve of the material of the security.

13. A security according to claim 12, wherein the coating consists of zinc oxide.

14. A security according to any one of claims 1 to 4, wherein the coating has electrically conducting properties.

15. A security according to claim 14, wherein the coating consists of stannic oxide.

16. A security having an authenticity hallmark in the form of a vacuum deposited coating on at least part of a paper substrate substantially as hereinbefore described.

17. A method for inspecting the authenticity of a printed security according to any one of claims 5 to 8 and 10 which comprises illuminating the hallmark

substance with light in a wavelength range below approximately 350 nm and at least two different wavelengths in succession and measuring the resultant fluorescent emission.

18. A method for inspecting the authenticity of a printed security according to claim 6 or 10, wherein the long-wave limit of the examination spectrum is chosen to have a shorter wavelength than the long-wave limit of the excitation spectrum for the fluorescent emission.

19. A method for inspecting the authenticity of a printed security according to claim 12, wherein the security is inspected in a wavelength range which follows the absorption edge of the pure hallmark substance in the short-wave range.

20. A method for inspecting the authenticity of a printed security according to any one of claims 1 to 16, wherein a plurality of properties are measured in succession depending on the hallmark substance.

21. A method according to claim 20, wherein the photoconductivity and fluorescence are measured.

22. A method according to claim 20, wherein the electrical conductivity and the optical transmission are measured.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1980.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.